

DescriptionA device for wrapping a bale of pasture or the likeTechnical Field

The present invention relates to a wrapping device used for wrapping a bale of hay or the like, and which is mounted on a round baler.

5 Background Art

Generally at the end of the bale formation cycle, when the bale has reached a desired diameter, it is necessary that the round baler perform the wrapping of the bale of pasture or the like.

This wrapping or binding operation, as is well known to those skilled in the art and  
10 those who use round balers, is performed by means of a wire or by means of a sheet-like material (e.g. a net), while the bale is still inside the round baler. After the wrapping or binding, the bale is discharged on the ground from the tailgate. In modern round balers the whole process is essentially automatic, and the operator only needs to set the final (desired) bale diameter, possibly in combination with other  
15 parameters like the density of the bale etc.

As regards the binding systems which make use of a wire, they have been known long before, and they essentially include an arm which is movable between two positions, that is, a first position or rest position, and a second position or operative position in which the binding wire is inserted between two of the rollers that laterally  
20 enclose the bale formation chamber; the wire is thereafter frictionally drawn (dragged) between the bale and belts of the chamber (or alternatively, in some regions, between the rollers of this chamber and the bale). The wire will evidently be unwound (drawn) from a storage coil which acts as a storage means (reservoir).

This system for introducing the wire in the bale formation chamber and that will  
25 hereafter be called "direct binding means introduction system", was already known a

long time ago, and it has been applied to a wrapping means – like a net or a plastic sheet - which uses the whole width of the baling chamber, by the company New Holland Belgium N.V. that has filed a corresponding European Patent application (publication number EP 0 432 830 B1) for such a system.

- 5 In this particular system applied by New Holland Belgium N.V. there is provided an element for the introduction of a net or the like, and this element is formed by a pair of arms capable of rotating between a first position and a second position, exactly in the same manner as in a system that makes use of a binding wire. In order to introduce the sheet (or net) directly into the baling chamber, there is provided a kind
- 10 of pliers biased by springs and formed by transversal sheet metal parts mounted between said pair of arms; moreover, the metal sheet parts directly enter into the baling chamber, causing the loose end part of the plastic sheet or net to be frictionally dragged inside the bale formation chamber (baling chamber), in a manner which is already known to a skilled person from the binding system that utilises a
- 15 wire.

A first disadvantage of employing this system is that the net or the like, which is dragged into the baling chamber, could possibly be damaged during its passage between the sheet metal parts, because it is subjected to sliding friction with the material of the sheet metal parts.

- 20 Unlike the binding system that makes use of a wire, the system which utilises a wrapping means (such as a net or a plastic film) that extends through the whole width of the baling chamber also has the problem of maintaining an outstretched condition of the net or plastic sheet, when the latter are unwound from the storage coil.

The cited European Patent application solves that problem by providing a particular

25 indentation on the free edges of the sheet metal parts of the above mentioned pliers. The relative motion between the wrapping means and the sheet metal parts of the pliers, should then insure an outstretched condition, or at least contribute in maintaining this outstretched condition of the wrapping means. However, this

relative movement could damage the net, as has already been highlighted.

From this point of the description on, and up to the claims, we shall only speak of a “net”, although we shall generally mean by this any suitable means used for wrapping/binding, which makes use of the total width of the baling chamber, and

5 which is apt to wrap and bind a bale.

The present invention specifically relates to a bale wrapping system to be used by a round baler and which operates according to a totally different way of introducing a net into the baling chamber of the round baler.

Therefore, a first object of the present invention consists in the realisation of an  
10 alternative device, or “indirect introduction system”, for introducing the net inside the baling chamber.

According to the invention, one of the rollers that delimit the bale formation chamber (=baling chamber) will itself perform the function of feeding the net from the outside to the inside of the baling chamber. It is therefore unnecessary to provide any kind of  
15 pliers formed by two thin sheet metal pieces, in mutual contact with one another, wherein the pliers directly enter into the chamber. The device that dispenses the sheet or film will have a totally different configuration. Moreover, there are no risks at all to damage the net.

A second object of the present invention consists in the improvement of the system  
20 used for outstretching the net, disclosed in the foregoing European Patent. By using simple technical means, the dispensing system of the invention will become much more suitable for the task of outstretching the net in the transversal direction, as compared with the pliers system.

A further object of the present invention consists in providing a clever expedient in  
25 the net dispensing system, that allows to initially drag the net towards the interior of the baling chamber, without practically encountering any resistance from the net which is being dragged.

This facilitates the operation carried out by the roller used to feed the loose free end

of the net into the baling chamber, since this roller will dispose of a slack (that is, not tensioned) section of the net, and can easily “recover” this section (or length) of the net in order to carry out its function.

## 5 Disclosure of Invention

The objects of the present invention are obtained, as regards the round baler itself, by the characterising features of claim 1, and as regards the wrapping method, by the features contained in claim 17.

The dependent claims are used to illustrate some particular features of the device and  
10 of the relative method.

Essentially, the dispensing device used for dispensing the wrapping means includes a set of rollers that exert a gripping action on a loose free end of the net, and – unlike the solution adopted in the European Patent EP 0 432 830 B1 -, in the second position of the dispensing device the free end of the net is in contact with a first roller  
15 of the baling chamber, this first roller defining the insertion gap for the net together with a second roller of the baling chamber; moreover, said first roller of the baling chamber, also called feed roller, transports the net (or the like) towards the insertion gap, and successively inserts the net (or the like) inside the gap. This system, which at first sight might seem more complex than the solution given in the cited European  
20 Patent, insures the following:

- a) the complete stretching of the net, until a moment immediately before its insertion (it will be enough to provide a spiralled roller also in the set of grip rollers);
- b) the total integrity of the wrapping means (that is of a net or the like), since that wrapping means is no more forced to pass through two metal sheet parts.

25 Other very advantageous aspects of the present invention will result from the features contained in the dependent claims and from the detailed description given below.

## Brief Description of Drawings

The present invention, its advantages, and its diverse innovative features, will now be disclosed with reference to some particular embodiments, which are only illustrative and by no means binding or limitative, and which are shown in the drawings, wherein:

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FIG. 1 schematically shows a lateral view of the wrapping device according to the present invention, in a first embodiment thereof, and in the rest or net-cutting position;

- 10 FIG. 2 is a lateral view analogous to Fig. 1, in which the wrapping device is in the net gripping position;

FIG. 3 is a lateral view analogous to Figs. 1 and 2, but with the wrapping device in the "operative" position, that is, during the wrapping operation itself;

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FIG. 4 is a lateral and schematic view of the wrapping device according to the present invention, in a second embodiment, and in the rest position or net-cutting position;

- 20 FIG. 5 is a side view analogous to Fig. 4, which however refers to the approaching step, during which a motorised roller of the dispensing device is rotated;

FIG. 6 shows once again the wrapping device according to the second embodiment of the invention, but this time in the net-gripping position;

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FIG. 7 is a sectional view, enlarged with respect to Figs. 4, 5, and 6, used to illustrate the details concerning three rollers of the dispensing device of the second embodiment, and the respective motorization of the central roller;

FIGS. 8, 9, 10 and 11 schematically show various positions of a variant of wrapping device according to the present invention, with regard to the second embodiment.

#### 5 Disclosure of Some Preferred Embodiments

Two specific embodiments of the present invention, together with a variant or modification of the second of these embodiments, will now be described extensively only for illustrative purposes and with the only aim to clarify how a technician in this field may concretely apply the principles of the invention.

- 10 Several aspects of the invention, which have not yet been mentioned, will result from this detailed description, while other aspects and advantages will be learned when the invention is put into practice.

Referring first to Fig. 1, this figure shows the wrapping device of the invention according to the first embodiment, in the rest position. This figure is very schematic,

- 15 and it only shows those parts which are necessary to understand the invention, whereas the remaining parts (which are standard in round balers) will be omitted altogether for simplicity since the skilled person is already aware of their existence. The wrapping device first includes a dispensing device 1, taking the form of a rocker lever, and including two arms that are pivotly mounted around the axis 2. In reality,  
20 the two arms of the rocker lever 1 may swivel around the outer side of two respective rings which are fixed to the respective opposite inner side walls of the round baler. On the inner part of these rings there are provided bearings for a transversal shaft 2, which extends between the rings, said transversal shaft being idly mounted in order to permit the advancement of the net.

- 25 Moreover, the wrapping device comprises a "reservoir", or storage means, for the net, which is formed of a tubular element 4 acting as a support and allowing rotation of a storage coil 3.

A cutting device 5 is also provided, which on its front part presents a series of cutting

elements 6 and which is connected – at its opposite end – to the dispensing device 1 by means of a tie rod 7 ; the latter is hinged at 8 on one side of the inner space of the round baler. Actually, a skilled person immediately realises that each element 5 is also formed of two parts located on a respective side of the inner space of the round  
5 baler.

An attachment 9 is rigidly connected to an arm of the cutting device 5, in order to engage the hook 10, and the latter is pivoted at 11 to the respective side of the round baler. The hook 10, in an intermediate position thereof, which is indicated by 12, is connected to a second tie rod 13, which in turn is connected to the rocker lever 1 at  
10 its other end.

The cutting device 5 is pivotly mounted around a transversal axis 32 (meaning by this preferably two rings that are fixed to the respective inner walls, each of which is associated to one of the arms of the cutting device 5).

The two tie rods 7 and 13 have respective slots 14 and 15 at their linkage point of  
15 connection to the rocker lever 1.

The wrapping device of the present invention also includes a brake 16 which is biased by springs (not shown) against the storage coil 3 for the net, this brake also contributing to maintain an outstretched and tensioned condition of the net when the latter is wrapped around the bale, during the bale wrapping operation, also called  
20 “operative step“ (“or working step”).

This brake 16 too is formed of two respective lateral arms and it includes a non-rotating crosspiece 17 which frictionally engages the net 3 and which rigidly connects said lateral arms of the brake 16 to each other. The opposite end of the brake 16 is hinged to a transversal axis 18. A third tie rod, 19, connects in an  
25 articulated manner an intermediate point 22 of the brake 16 to a pin 20 of the rocker lever 1, this pin 20 being free to slide inside a slot 21 of the third tie rod 19. An electrically controlled linear actuator 23 is used to control the displacements of the dispensing device 1.

This solution is very advantageous, but it is obvious that other systems could be used as well in order to control the rotational movement of the dispensing device 1 in the clockwise and counter-clockwise directions around the axis 2.

Along its path through the dispensing device 1, starting from the storage coil of the net 3, the net 3 direction is changed many times by a plurality of rollers, some of which (see rollers 2 and 18) have already been mentioned. The two rollers 24 and 25 are integral with the two arms of the dispensing device 1, on the upper part of the rocker lever 1. The net length counting roller 2 (idle roller) determines, by means of an appropriate sensor, the distance covered by the net 3.

10 In the lower part, the dispensing device 1 includes two further rollers 26, 27. The roller 26 is directly and idly mounted on the dispensing device (rocker arm) 1, and it extends from one arm to the other. The roller 27 is mounted on a small lever 28 (one on each side, as usual), and said lever is pivoted on the respective arm 1 at a first end 30 thereof, while being at the same time biased by a spring 29 – at its opposite end –  
15 towards the arm 1, thereby obtaining the result of frictionally engaging the net that passes through the idle rollers 26, 27. A sheet (plate) 31 is fixed to the structure of the dispensing device 1, for exerting a protection action (see below) with respect to the roller 37 around which the belts, ribbons, elongated planks or the like are driven, since said roller rotates in the opposite direction with respect to the direction of  
20 introduction of the net in the bale formation chamber.

At the end of a bale wrapping cycle, the net cutting device 5 rotates clockwise around its axis 32, thereby cutting the net 3 (see FIG. 1, broken line 3') and leaving a free end of net 3'; the latter, by gravity, immediately falls in the position denoted by the continuous line 3". Thus, at the beginning of the next wrapping cycle, the free end  
25 3" of the net hangs down and the whole wrapping device is in the rest position (which coincides with the net cutting position), ready for the next cycle.

A description will next be given of the operation of the wrapping device, which uses a net, according to this first embodiment of the present invention, the description



being given with reference to the figures 1, 2 and 3.

Once the bale 33 has reached the desired diameter within the baling chamber 34, while still continuing to rotate in the direction of arrow F due to the action of the ribbons 35 (rollers, or transversal rods 35 in other solutions), the electronic control  
5 unit of the round baler will supply electric current to the actuator 23 and this actuator will move the rocker lever 1 from its rest position (Fig. 1), to a position (Fig. 2) next to a roller 36 which bounds on the baling chamber, which roller, in combination with a second roller 37, defines a gap 38 used to introduce the net 3" inside the baling chamber 34.

- 10 The free end 3" of the net (see Fig. 2), and a sheet or plate 39 (integral with the lever 28), engage the roller 36, and the latter transports the net towards the inside of the baling chamber 34. The rocker lever 1 moves the tie rod 19 which is connected with the brake 16, thereby disengaging the crosspiece 17 from the storage coil 3, so that the latter can freely rotate. At the same time, the rocker lever 1 moves the first tie rod  
15 7 downwards, thereby reaching the end of the slot 14; in this way, the cutting device 5 rotates around the axis 32 and reaches the position of engagement to the hook 10 (Fig. 2). The net is transported by the roller 36 (that preferably has integral ribs 40) and is drawn towards the inside of the chamber by the same roller 36 and by the bale (see broken line 3'", which shows the free part of net 3 which becomes "trapped"  
20 between the roller 36 and the bale 33). The portion 41 of the net (see upper part of the rocker lever 1) which becomes loose during the rotation towards the position of Fig. 2, facilitates the traction exerted by the roller 36. The roller 2, which is driven into rotation by the movement of the net 3, will determine – by its sensor – the quantity of net that gets into the chamber 34. In this case, however, as soon as the  
25 roller 2 starts rotating, the actuator 23 will start moving in the opposite direction, thereby displacing the rocker lever 1 to the operative (working) position (see Fig. 3), which is defined by an electric sensor not shown in the drawings.

During the latter movement, the brake 16 is pushed by its springs (not shown) and

returns to its position in abutment with the net 3 on the storage coil, in order to insure that the net 3 is in an outstretched condition on the bale. The rocker lever 1 remains in this position until the programmed length of net has been reached, as measured by the net length counting roller 2. At the end of this phase, the rocker lever 1, which is  
5 moved by the actuator 23, gets to the rest position (Fig. 1). During this movement, the second tie rod 13 moves the hook 10 in the anticlockwise direction and releases the attachment 9, and consequently, the cutting device 5, which, by rotating in the clockwise direction, will perform the cutting of the net 3, thereby leaving a net section 3' (3'') which projects from the roller 27.

10 Fig. 2 illustrates the "net gripping" position, and it may be noted that the free end 3" is pushed by the sheet (plate) 39 against the roller 36 with ribs 40, and this roller carries out the insertion of the net 3 into the chamber 34.

In this context, the word "ribs" indicates any element different from a smooth roller, which is suited to enable the transport roller 36 to exert a drawing action .

15 Fig. 3 illustrates the position in which the net can be supplied into the chamber 34, also called operative or working position (or wrapping position), that comes before the return to the cutting position (Fig. 1).

It should be noted that normally the net length counting device 2 has a surface provided with spiral-like ribs, which are suited to stretch out the net 3. These spiral-  
20 like ribs may be formed either by added material or by removing material from the outer surface of the rollers.

These spiral-like ribs have opposite features (one of them is right-hand while the other is left-hand), and each of them extends only along half the length of the net length counting roller 2.

25 According to the present invention, the roller 26 will also have spiral-like ribs. This simple technical measure allows to maintain the net 3 in an outstretched condition, up to the last moment before it is fed into the baling chamber 34. This feature allows the rollers 26, 27 to exert a gripping and a stretching action on the net 3, which is

more effective than that of the pliers of the prior art , and above all, without risks of damaging the net. Moreover, it may be seen that the free end 3", instead of being directly inserted through the gap 38 between the rollers 36 and 37, is simply drawn close to the roller 36, while the latter provides for its introduction through the gap 38.

- 5 In Fig. 2, it may be noted, for instance, that the contact line between the free end 3" and the roller 36 (or one of its fins 40) is approximately shifted by an angle of about 90° with respect to the gap 38.

Another advantage with regard to the background art is that the brake 16 always keeps the net in a tensioned state during the binding (wrapping) of the bale, while it  
10 moves away from the storage coil 3 only for the time that is strictly required to carry out the insertion of the net inside the gap 38. A further advantage is due to the fact that the net portion 41, which remains loose (see Fig. 2), facilitates the introduction of the net, which is performed by the roller 36. This advantage is achievable by a particular configuration of the upper part of the rocker lever 1. The resistance to be  
15 overcome by the roller 36 during this initial phase is therefore totally negligible.

Thus, it may be seen that this system differs substantially from the already known arrangements according to which the wrapping/binding means, e.g. a wire or a net, are directly introduced (inside the chamber 34).

A further essential simplification with regard to the structure of the wrapping device  
20 according to the present invention, as compared with the prior art, is that the cutting device 5 does not require a separate driving means, nor complex mechanisms for transmitting the motion; instead, it functions only with a hooking/ unhooking mechanism, and by interacting with the movement of the rocker lever which is controlled by the actuator 23.

- 25 With reference to Figs. 4, 5, 6 and 7, we will now describe the second embodiment of the present invention.

This second embodiment differs from the first only in some features, so that the same reference numbers will be maintained as much as possible, except (obviously) for

components that have no identical counterpart.

Nor will it be necessary to repeat the preceding description for identical parts that are already contained in the first embodiment.

In this second embodiment, the lower part of the rocker lever 1 differs from the first  
5 embodiment in that besides the two rollers 26, 27 - in the present case denoted by 26', 27' - there is provided a third roller 42. Moreover, the roller 42 is idly mounted on a second lever 43 which is pivoted on the respective arm of the rocker lever 1, while a spring 44 (one for each arm of 1) connects the free end of the lever 43 to the free end of the lever 28'. The net 3 extends along a zigzag path between the three  
10 idle rollers 26', 27', 42. However, according to this embodiment, the central roller 26' is motorised. This means that during the rotational movement that causes the advancement of the rocker lever 1 towards the roller 36, the central roller 26' drags the net and gradually increases the length of the free end 3'' (see Figs. 4 and 5). The means used to drive (motorise) the roller 26' may be of any kind, e.g. electric,  
15 hydraulic, or mechanical. In the present description we will only consider two (mechanical) types of drive means. Figs. 4 to 7 show a first kind of mechanical drive means (corresponding to the second embodiment of the invention), whereas Figs. 8 to 11 illustrate a second arrangement of mechanical drive means for the roller 26'' (corresponding to a variant of the second embodiment). However, it is obvious that  
20 these specific solutions for obtaining driving arrangements for the roller 26' (or 26''), are purely illustrative and are not intended to limit the invention, it being understood that a skilled person could choose among a vast number of alternative solutions.

The central roller 26' (Figs. 4 – 7) is driven by a gear wheel 45 which is integrally connected to the central roller 26', this gear wheel engaging a rack 46 integrally  
25 attached to the frame 47 of the machine, on the outer side of the latter (one for each side).

Thus, it may be realised that the shaft 48 of the roller 26' crosses the respective arm of the rocker lever 1 and is fixed (by a key or in any suitable manner) to a cylindrical

part 49. Between the latter and the gear wheel 45 there is provided a device 50 (for instance a freewheel or sprag clutch), allowing the rotation of the roller 26' in one direction only (the anticlockwise direction indicated in Figs. 4 – 6 ).

Therefore, the operation is the same as already described for the first embodiment, and the rocker lever 1 will - as before - be able to occupy three positions, as has been detailed above, that is: rest (or cutting) position, net gripping position, operative position.

It should be noted that when the roller 26' is set into rotation by the net which is dragged by the bale, the gear wheel 45 remains stationary. When the rocker lever 1 moves towards the operative position (and after, towards the cutting position), the gear wheel 45 and the roller 26' rotate in opposite directions.

This second embodiment is an alternative (option) for the skilled person. In fact, the distance between the blades 6 of the cutting device 5 and the position of the rocker lever 1, at the time the net is cut, determines the length of the free end of the net (see Figs. 1 and 4). This distance must be selected to be greater in case of Fig. 1, since in the latter solution, during the approaching movement of the rocker lever 1, the length of the free end (of the net) does not increase. In case of Fig. 4, the said distance could be small, since the motorised roller 26' will insure an increase of the free end's length, by dragging (drawing) the net (and unrolling it from the coil 3). A possible alternative of the drive means of the roller, as shown in Figs. 8 to 11, will be briefly discussed.

In this case, the extension (or shaft) of the roller 26'' supports an external gear – which corresponds to the gear 45 of Fig. 7 -, and which, even in this case, is associated to a freewheel 50 or a similar device (with the same function). A chain 51 is fixed at the end points a and b , on the respective outer wall of the round baler.

Two hubs, or pins, 52, 53, are rigidly fixed to the respective arm of the rocker lever 1, and they extend through the slot 54 that is obtained on the respective wall of the frame 47 of the round baler. The chain direction is changed by said rigid pins or hubs

52, 53, in such a way as to follow the contour of the gear wheel (analogous to 45) on its upper part, so that the chain will follow a zigzag path between the components 52, 53 and the gear wheel (analogous to the gear wheel 45).

The two small levers analogous to 28', 43, are now indicated by numerals 28'', 43''

5 (Fig. 9).

In Fig 8 and in the following figures, it may be noted that the plate 39 of Fig. 2 and Fig. 4 has been omitted. Although not strictly necessary, this element 39 (that could even be made of plastics or any other suitable material) is in any case preferable, in order to push the net against the roller 36, thereby insuring – in a more reliable

10 manner – that there is a contact between the net and the upper surface of the roller 36.

It should be noted that the roller 26'' (driven roller) could be provided with helical ribs, in the same way as the net-length counting roller 2, or, alternatively, it could be rubber-coated in order to increase the friction with the other rollers 27' and 42. The  
15 spiral (or helical) ribs could then be present on the other rollers 27', 42, to insure a greater adherence of the motorised roller.

The present invention has been described only with reference to some particular embodiments. Several modifications could be made by a skilled person, without departing from the same inventive concept.

20 For example, the set of rollers that are mounted on the lower part of the rocker lever 1, must include at least two rollers, one of which, at least, has preferably spiral ribs (for stretching out the net immediately before its introduction in the baling chamber 34). Preferably, at least two rollers are biased by springs, one against the other, in order to grip the net in a more reliable manner, e.g. after the cutting operation (so as  
25 to insure the presence of the free end of the net). At least one roller may be motorised, in case the mutual spatial arrangement of the rocker lever 1 and the cutting device 5 do not allow to obtain a sufficient length for the free end to insure a dragging action (or even a mere contact) between the roller 36 and the net 3.

All rollers may be formed by a single material or coated with a different material (e.g. metal core and elastomeric or rubber coating). The actuator 23 could be replaced by any kind of driving mechanism. All these modifications are obviously within the reach of a skilled person and are included in the scope of the invention.

- 5 At last, we note that all four rollers (36, 37, 55 and 56) that delimit part of the bale formation chamber, are mounted on stationary axes, so that, except the rotation about their own axis, their spatial position is in fact invariable during the whole operation of the round baler and particularly during a wrapping cycle; therefore, the wrapping cycle may start with any diameter of the bale which occupies the interior of the bale  
10 formation chamber.

We note finally that the wrapping process according to the invention is not generally limited to the disclosed embodiments, for which there exist three positions of the dispensing device 1, and that, for instance, the net gripping position could (in an alternative embodiment) coincide with the operative position. In this case, if a brake  
15 is used, the latter should again touch the net on the storage coil 3, immediately after the net starts to be wrapped (condition shown in Fig. 2), in order to insure that the net remains stretched during wrapping (binding of the bale). In this solution, it is preferable that the brake be actuated by a separate mechanism of its own.

Alternatively, the brake could constantly remain in the braking position, if the tie rod  
20 19 is omitted.